

**A TYPICAL
WJ 9040 DF SYSTEM**



WATKINS-JOHNSON



**A TYPICAL
WJ 9040 DF SYSTEM**

This document and the subject matter disclosed herein are proprietary items to which Watkins-Johnson Company retains the exclusive right of dissemination, reproduction, and sale.

**WATKINS-JOHNSON COMPANY
700 Quince Orchard Road
Gaithersburg, MD 20878**

September 1987

WARNING

This equipment employs dangerous voltages which may be fatal if contacted. Exercise extreme caution in working with this equipment with any of the protective covers removed.

TABLE OF CONTENTS

SECTION I

GENERAL DESCRIPTION

<u>Paragraph</u>		<u>Page</u>
1.0	Introduction	1-1
1.1	DF Processing Technique	1-1
1.2	Electrical Characteristics	1-2
1.2.1	WJ 9040 EFR100 Equipment Frame	1-2
1.2.1.1	WJ 9040 EPS100 Power Supply	1-2
1.2.1.2	WJ 9040 IOM108 I/O Control Module	1-2
1.2.1.3	WJ 9040 SRM105A Site Reference Module	1-2
1.2.1.4	WJ-8628-4 VHF/UHF Receiver	1-2
1.2.1.5	WJ 9040 DDF102 Direction Finder Direction	1-3
1.2.2	WJ-98XX DF Antenna	1-3
1.3	Mechanical Characteristics	1-3
1.4	Equipment Supplied	1-4
1.5	Equipment Required But Not Supplied	1-4
1.6	Equipment Specifications	1-4

SECTION II

INSTALLATION

<u>Paragraph</u>		<u>Page</u>
2.0	Unpacking and Inspection	2-1
2.1	Unpacking	2-1
2.2	Installation Procedures	2-1
2.2.1	DF System Installation	2-2
2.2.1.1	Direction Finder/Receiver/EFR100 Equipment Frame	2-2
2.2.1.2	WJ-98XX DF Antenna	2-2
2.2.2	Input/Output Connectors	2-3
2.2.2.1	WJ 9040 DDF102 Direction Finder Direction	2-3
2.2.2.1.1	DF Input (J1)	2-3
2.2.2.1.2	IF Output (J2)	2-3
2.2.2.1.3	WJ 9040 Backplane Connector (J3)	2-4
2.2.2.1.4	SM Output (J4)	2-4
2.2.2.1.5	DF Video (J5)	2-4

TABLE OF CONTENTS - Continued

INSTALLATION - (Cont'd)

<u>Paragraph</u>		<u>Page</u>
2.2.2.1.6	DF Antenna (J6)	2-4
2.2.2.1.7	Remote I/O (J7) - (Optional)	2-4
2.2.2.1.8	DF Antenna -1 (J8), -2 (J9), -3 (J10)	2-4
2.2.2.1.9	OMNI (J11)	2-4
2.2.2.1.10	RF IN (J12)	2-4
2.2.2.1.11	RF Output (J13)	2-5
2.2.2.1.12	IF Control (A5J1)	2-5
2.2.2.1.13	21.4 MHz IF Demodulator Connector: Video Out (J1)	2-5
2.2.2.1.14	21.4 MHz IF Demodulator Connector: 21.4 MHz IF Input (J3)	2-5
2.2.2.1.15	21.4 MHz IF Demodulator Connector: Digital Interface (A4J1)	2-6
2.2.2.1.16	21.4 MHz IF Demodulator Unused Connections	2-6
2.2.2.2	WJ-8628-4 Receiver	2-6
2.2.2.2.1	Power, Command/Control (J1)	2-6
2.2.2.2.2	50 MHz Reference Input (J2)	2-7
2.2.2.2.3	Auxiliary Output (J2)	2-6
2.2.2.2.4	IF Output (A2J4)	2-7
2.2.2.2.5	Selected Video Output (J1)	2-7
2.2.2.2.6	SM Output (J2)	2-7
2.2.2.2.7	RF Input (J1)	2-8
2.2.2.2.8	Power Input (A3J1)	2-8
2.2.2.3	WJ-9881 DF Antenna	2-8

SECTION III

OPERATION

<u>Paragraph</u>		<u>Page</u>
3.0	Introduction	3-1
3.1	Controls and Indicators	3-1
3.1.1	WJ 9040 DDF102 Direction Finder Direction	3-1
3.1.1.1	Front Panel Controls	3-1
3.1.1.1.1	BACKLIGHT ON Switch	3-1
3.1.1.1.2	DISPLAY ADJUST Control	3-1
3.1.1.2	Front Panel Keypad Switches	3-1
3.1.1.2.1	IF BW	3-2

TABLE OF CONTENTS - Continued

OPERATION - (Cont'd)

<u>Paragraph</u>		<u>Page</u>
3.1.1.2.2	OFFSET	3-2
3.1.1.2.3	R/LCL.	3-2
3.1.1.2.4	CLR.	3-2
3.1.1.2.5	LOB.	3-2
3.1.1.2.6	INT TIME	3-3
3.1.1.2.7	GATE.	3-3
3.1.1.2.8	Numeric Keys 0 - 9	3-3
3.1.1.2.9	TEST	3-3
3.1.1.2.10	AUX.	3-5
3.1.1.3	DF Display	3-6
3.1.1.4	Front Panel Status Display	3-6
3.1.1.4.1	BEARING OFFSET Display	3-7
3.1.1.4.2	QUAL FACTOR Display	3-7
3.1.1.4.3	Bearing Display	3-7
3.1.1.4.4	REMOTE/LOCAL Display	3-8
3.1.1.4.5	IF BW Display	3-8
3.1.1.4.6	GATED MODE Display	3-8
3.1.1.4.7	INT TIME Display	3-8
3.1.1.4.8	Error Messages, Operator Prompts, Misc. Displays	3-8
3.1.1.5	Remote Control Commands for WJ-8971A-6	
	Direction Finder	3-8
3.1.1.5.1	Remote Control	3-9
3.1.2	WJ-8628-4 Receiver	3-10
3.1.2.1	Introduction	3-10
3.1.2.2	Controls and Indicators	3-11
3.1.2.2.1	Front Panel Controls	3-11
3.1.2.2.1.1	BACKLIGHT ON Switch	3-11
3.1.2.2.1.2	DISPLAY ADJUST Potentiometer.	3-11
3.1.2.2.1.3	RF GAIN Control.	3-11
3.1.2.2.1.4	AUDIO GAIN Potentiometer.	3-11
3.1.2.2.1.5	PHONES Jack.	3-12
3.1.2.2.1.6	TUNE Knob	3-12
3.1.2.2.1.7	Cursor Control Switch	3-12
3.1.2.2.2	Front Panel Keypad Switches	3-12
3.1.2.2.2.1	BFO +/- Switch	3-12
3.1.2.2.2.2	kHz Switch	3-12
3.1.2.2.2.3	MHz Switch	3-13
3.1.2.2.2.4	OPR AID Switch	3-13
3.1.2.2.2.5	CLR Switch	3-13
3.1.2.2.2.6	Numeric Switches 0-9	3-13
3.1.2.2.2.7	Upper Case/Lower Case Switch	3-13
3.1.2.2.2.8	INCL/L-OUT Switch	3-13
3.1.2.2.2.9	SYS CLR Switch	3-13
3.1.2.2.2.10	SET/SCAN Switch.	3-14

TABLE OF CONTENTS - Continued

OPERATION - (Cont'd)

<u>Paragraph</u>		<u>Page</u>
3.1.2.2.2.11	DWL Switch	3-14
3.1.2.2.2.12	R/LCL COS Switch	3-14
3.1.2.2.2.13	EXEC Switch.	3-14
3.1.2.2.2.14	RCL Switch	3-14
3.1.2.2.2.15	STO Switch	3-14
3.1.2.2.2.16	DET Switch	3-14
3.1.2.2.2.17	IF BW Switch	3-15
3.1.2.2.2.18	GAIN Switch.	3-15
3.1.2.2.3	Front Panel Display	3-15
3.1.2.2.3.1	DET MODE Display.	3-15
3.1.2.2.3.2	CHAN/ADDR Display.	3-15
3.1.2.2.3.3	IF BW Display	3-15
3.1.2.2.3.4	CONTROL STATUS Display.	3-15
3.1.2.2.3.5	GAIN MODE Display	3-15
3.1.2.2.3.6	BFO (kHz) Display	3-15
3.1.2.2.3.7	SIGNAL STRENGTH/COS THRESHOLD Display	3-16
3.1.2.2.3.8	FREQUENCY (MHz) Display.. . . .	3-16
3.1.2.2.3.9	COS STAT Display	3-16
3.1.2.2.3.10	TUNE/AFC Display.	3-16
3.1.2.2.3.11	SHIFT Display	3-16
3.1.2.3	Remote Control Commands for WJ-8628-4 Receiver	3-17
3.1.3	WJ-9881 DF Antenna	3-19
3.2	DF Subsystem Operation	3-19
3.2.1	General DF Operating Principles	3-20
3.2.1.1	DF Site Selection	3-20
3.2.1.2	Signal Acquisition	3-20
3.2.1.3	Signal Types	3-21
3.2.1.3.1	Continuous Signal	3-21
3.2.1.3.1.1	Integration Time Selection	3-21
3.2.1.3.2	Short Duration Signals	3-21
3.2.1.4	Receiver Scanning Application Program	3-22
3.2.2	DF Subsystem Built-In Test (BIT)	3-22
3.2.2.1	WJ 9040 DDF102 Direction Finder	3-22
3.2.2.1.1	Direction Finder	3-22
3.2.2.1.2	Direction Finder/IOM108 Communication	3-23
3.2.2.2	WJ-8628-4 Receiver BIT	3-23
3.2.2.3	WJ-9881 DF Antenna BIT	3-23

TABLE OF CONTENTS - Continued

LIST OF ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
SECTION I		
1-1	WJ 9040 DF System	1-5
1-2	Calculation of Line of Bearing (LOB) from Phase Differences Between Antenna Elements	1-6
SECTION II		
2-1	WJ 9040 DF System (Typical)	2-9
2-2	WJ 9040 DDF102 Direction Finder Rear Panel	2-10
2-3	WJ-8628-4 VHF/UHF Receiver Rear Panel	2-11
SECTION III		
3-1	WJ 9040 DDF102 Direction Finder Front Panel Controls . . .	3-24
3-2	WJ 9040 DDF102 Direction Finder Front Panel Display . . .	3-25
3-3	Receiver Front Panel Controls	3-26
3-4	Front Panel Keypad Switches	3-27
3-5	LCD Parameter Display Locations	3-28

LIST OF TABLES

<u>Table</u>		<u>Page</u>
SECTION III		
3-1	Test Functions	3-4
3-2	Auxiliary Functions	3-5
3-3	Power-Up Status of DF	3-7
3-4	WJ 9040 DDF102 Direction Finder Direction Finder IEEE-488 Remote Commands.	3-9
3-5	WJ-8628-4 Receiver IEEE-488 Remote Commands.	3-17



Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_05505

NOTE

This WJ-9040 DF SYSTEM manual describes a typical WJ-9040 DF Subsystem in detail. Different configurations or customer selection of components may cause some minor changes to the information covered in this manual. However, the general information and basic theory of operation will apply to most WJ 9040 DF Systems.

SECTION 1

GENERAL DESCRIPTION

1.0 INTRODUCTION

The WJ 9040 Direction Finder Subsystem is a WJ 9040 Modular Receiving System with a direction finding capability. The WJ 9040 DF System is composed of the following components:

- a. WJ 9040 DDF102 Direction Finder ,
- b. WJ-8628-4 VHF/UHF Receiver,
- c. WJ-98XX DF Antenna,
- d. WJ 9040 EFR100 Equipment Frame with:
 1. EPS100 Power Supply,
 2. SRM105A Site Reference Module,
 3. IOM108 Interface Module.

This DF system is shown in Figure 1-1.

1.1 DF PROCESSING TECHNIQUE

The Direction Finder operates on a Single-Channel Interferometer principle. Refer to Figures 1-1 and 1-2. The DF Antenna is comprised of four half-wave dipole antennas. The Direction Finder begins its line-of-bearing (LOB) calculation by turning on the dipole antennas one at a time in a circular sequence (antenna 1, 2, 3, 4, 1, ...). The phase differences of the RF signal which exists between each antenna dipole are measured by the DF. The angle of arrival is calculated by the formulas shown in Figure 1-2. It is important to note that only one Receiver is used in this process and that the Direction Finding Process is based on phase measurements between two antenna dipoles, hence the name Single-Channel Interferometer.

1.2 ELECTRICAL CHARACTERISTICS

Electrical characteristics of the major components are described in the following paragraphs.

1.2.1 WJ 9040 EFR100 EQUIPMENT FRAME

The Direction Finder and the WJ-8628-4 Receiver are co-located in the same WJ 9040 EFR100 Equipment Frame. The EFR100 Equipment Frame provides a mechanical housing for mounting these two units into a standard 19-inch rack frame. The EFR100 Equipment Frame also provides the signal distribution between the EPS100 Power Supply, IOM108 I/O Control Module, the Direction Finder and the Receiver. Refer to the WJ 9040 System Common Equipment Instruction Manual for details.

1.2.1.1 WJ 9040 EPS100 Power Supply

Power is supplied through the WJ 9040 EPS100 Power Supply. It supplies 4 unregulated voltages: +29, +18.3, -18.3 and +8.2 VDC to modules installed in the EFR100. These voltages are regulated within each module.

1.2.1.2 WJ 9040 IOM108 I/O Control Module

The IOM108 I/O Control Module provides the communication path between the Direction Finder and Receiver as well as a remote I/O control path to an external controller. All modules within the EFR100 are controlled through this single I/O port on the IOM108 I/O Control Module. RS-232 and IEEE-488 I/O control formats are available.

1.2.1.3 WJ 9040 SRM105A Site Reference Module

The SRM105A Site Reference Module provides a 50 MHz reference signal for the Receiver.

1.2.1.4 WJ-8628-4 VHF/UHF Receiver

The basic WJ-8628-4 VHF/UHF Receiver is capable of 20 to 512 MHz reception. Options are available to extend the frequency range of the Receiver. The main function of the Receiver in the DF subsystem is to acquire a signal of interest for the Direction Finder. The Direction Finder, when commanded, will generate a LOB (Line-of-bearing) for the acquired signal. For details of the Receiver, refer to the WJ-8628-4 VHF/UHF Receiver Instruction Manual.

1.2.1.5 WJ 9040 DDF102 Direction Finder Direction Finder

The Direction Finder is the central control element for LOB generation. The DF Antenna is controlled by the Direction Finder, the RF output of the DF Antenna is returned to the Direction Finder. This RF signal is then routed to the Receiver RF input. The Signal Monitor (SM) output of the Receiver (wideband 21.4 MHz IF signal) is then passed into the DF input of the Direction Finder. The Direction Finder then processes this signal to derive a LOB. Consult the **WJ 9040 DDF102 Direction Finder Direction Finder Instruction Manual** for details on this process.

1.2.2 WJ-98XX DF ANTENNA

The WJ-98XX Series DF Antenna is controlled by the Direction Finder. The DF Antennas contained in the WJ-98XX Series are:

- | | |
|------------|--------------|
| a. WJ-9871 | d. WJ-9880 |
| b. WJ-9872 | e. WJ-9880-1 |
| c. WJ-9873 | f. WJ-9881 |

Consult the Watkins-Johnson Company Data Sheets for the electrical and mechanical characteristics that match your requirements.

The RF output of the DF Antenna, when controlled by the Direction Finder during a LOB generation cycle, is a sequence of RF signal segments each with a certain phase differences between each other. The Direction Finder detects and measures these phase differences to calculate a LOB. See **Figure 1-2** for a discussion of this calculation.

1.3 MECHANICAL CHARACTERISTICS

The DF Subsystem is designed for mounting in a standard 19-inch rack cabinet (except for the DF Antenna). The frames can accept slides or brackets for easy rack mounting. The frames occupy 20 inches of depth. The DF Antenna mounting is customer defined.

All operator controls for manual operation are located on the front panels of the Receiver, Direction Finder and Angle Simulator. All the interconnections made between modules are done through connectors on the rear panel. Most of The RF connections are SMA coaxial connectors. The DF Antenna connector is a multi-pin plug.

1.4 EQUIPMENT SUPPLIED

The equipment supplied is:

- a. WJ 9040 DDF102 Direction Finder,
- b. WJ-8628-4 VHF/UHF Receiver,
- c. WJ-9881 DF Antenna,
- d. WJ 9040 EFR100 Equipment Frame with:
 1. EPS100 Power Supply,
 2. SRM105A Site Reference Module,
 3. IOM108 Interface Module.

1.5 EQUIPMENT REQUIRED BUT NOT SUPPLIED-

The DF Subsystem, as described above, is complete for operation without any additional requirement for auxillary equipment. However a Signal Monitor greatly aids in signal acquisition. Audio monitoring devices such as loud speaker or headphones are also recommended. Consult the WJ-9040 System Catalogs for other accessories to meet your requirements.

1.6 EQUIPMENT SPECIFICATIONS

Refer to the Instruction Manuals for the individual modules. The DF system specifications are found in the Direction Finder manual.

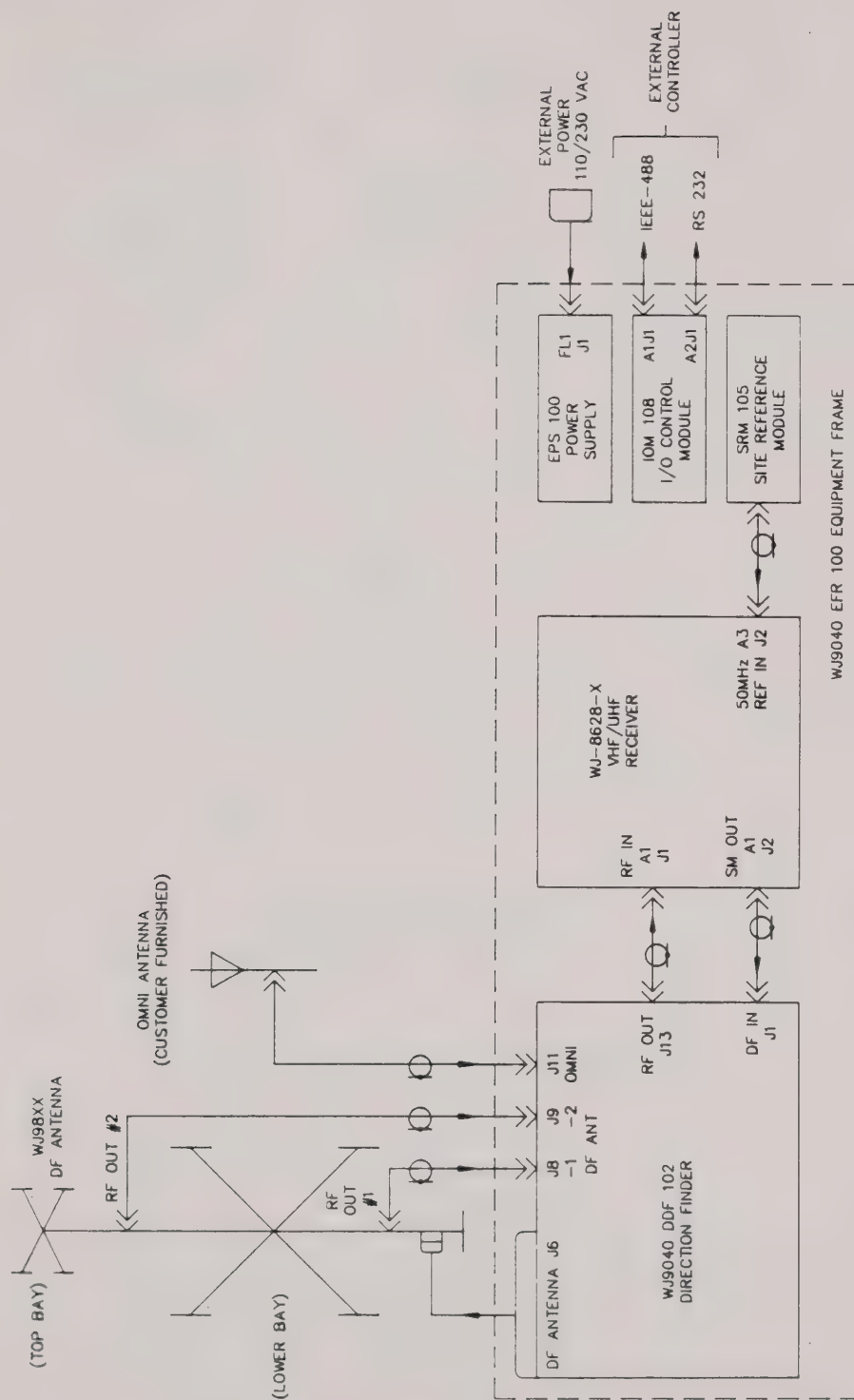
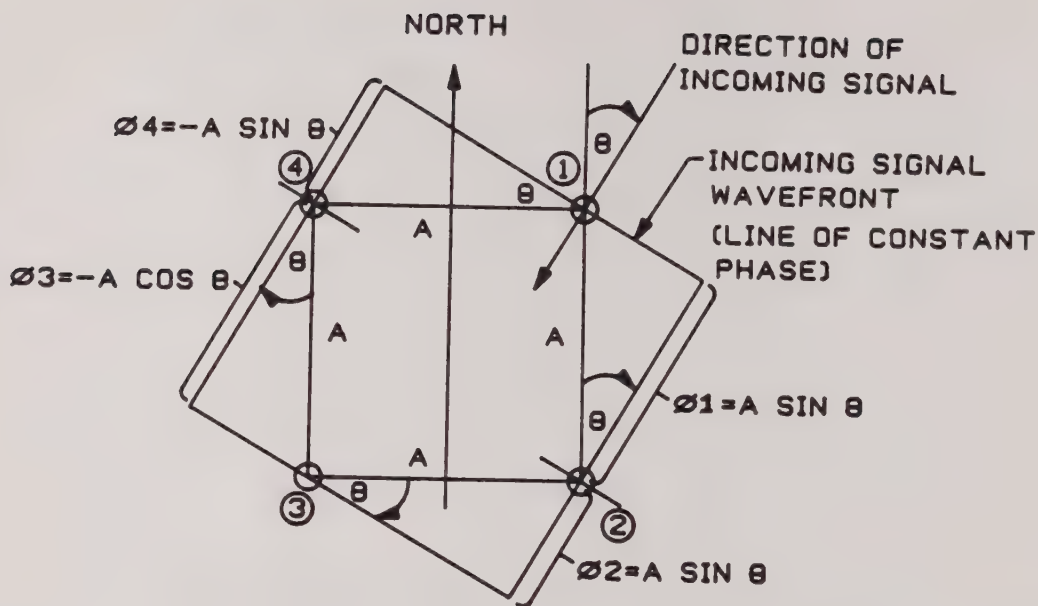


Figure 1-1. WJ 9040 DF System



TOP VIEW OF THE ANTENNA

Where: θ

A = distance between antenna elements

θ = line of bearing (LOB)

ϕ = phase difference between antenna elements

To find: θ

If: $\tan \theta = [\sin \theta / \cos \theta]$

Then: $\theta = \text{ARC TAN} [\sin \theta / \cos \theta]$

Since: $\phi_1 = -\phi_3 = A \cos \theta$

$\phi_2 = -\phi_4 = A \sin \theta$

Then: θ can be calculated in four different ways using ϕ_1 , ϕ_2 , ϕ_3 and ϕ_4 :

$$\theta_1 = \text{ARC TAN} [\phi_2 / \phi_1]$$

$$\theta_2 = \text{ARC TAN} (-[\phi_2 / \phi_4])$$

$$\theta_3 = \text{ARC TAN} [\phi_4 / \phi_3]$$

$$\theta_4 = \text{ARC TAN} (-[\phi_4 / \phi_1])$$

The final θ is calculated as:

$$\theta = [\theta_1 + \theta_2 + \theta_3 + \theta_4] / 4$$

Figure 1-2. Calculation of Line of Bearing (LOB) from Phase Differences Between Antenna Elements

SECTION II

INSTALLATION

2.0 UNPACKING AND INSPECTION

Examine the shipping cartons for damage prior to unpacking the equipment. If a carton appears to be damaged, have the carrier's agent present when the equipment is unpacked. If this is not possible, retain all packaging material and shipping containers for the carrier's inspection to verify damage to the equipment after unpacking. Also verify that the equipment shipped corresponds to the packing slip. Contact the Watkins-Johnson Company, CEI Division, or your Watkins-Johnson representative for any discrepancies or shortages.

The units were thoroughly inspected and factory adjusted for optimum performance prior to shipment. It is, therefore, ready for use upon receipt. After uncrating and checking contents against the packing slip, visually inspect all exterior surfaces for dents and scratches. If external damage is visible, remove the dust covers and inspect the internal components for apparent damage. Then check the internal cables for loose connections, and plug-in items such as printed wiring boards, which may have been loosened from their receptacles.

2.1 UNPACKING

If the equipment must be prepared for reshipment, the packing methods should follow the pattern established in the original shipment. If retained, the original materials can be reused to a large extent or at least provide guidance for the repackaging effort. Conditions during storage and shipment should be limited as follows:

- a. Maximum humidity: 95% (no condensation)
- b. Temperature range: -30 dgs C to 85 dgs C

2.2 INSTALLATION PROCEDURES

The DF Subsystem is designed to be mounted in standard 19-inch equipment racks. Specific installation procedures for the EFR100 Equipment Frame are covered in the WJ-9040 System Common Equipment Instruction Manual. However, the following general guidelines should be observed when using the equipment in a WJ 9040 operational environment:

- a. Operating temperature range should be from 0 degree C to +50 degrees C.
- b. Free air circulation should be allowed between equipment frames. Multiple stacking significantly increases ambient temperatures.

2.2 INSTALLATION PROCEDURES - (Continued)

- c. Use only stable, properly grounded AC power for the WJ-9040 equipment.
- d. Secure the DF in the frame by rotating the four front panel locking screws clockwise until tight.

2.2.1 **DF SYSTEM INSTALLATION**

The following paragraphs cover installation procedures for components of the system.

2.2.1.1 Direction Finder/Receiver/EFR100 Equipment Frame

The DF Subsystem is shown in Figure 2-1. The DF is co-located in the same EFR100 Equipment Frame as the WJ Receiver. There are two connections required between the Receiver and the DF :

- a. WJ-8628-4 SM OUT (A1J2) to DF IN (J1),
- b. WJ-8628-4 RF IN (A1J1) to DF RF OUT (J13).

These connections are made with coaxial cables with SMA connectors on each end. Make sure that the Receiver is installed in its proper manner as described in the WJ 9040 Common Equipment Instruction Manual and the WJ-8628-4 UHF/VHF Receiver Instruction Manual. Normally, this equipment will already be installed at the factory.

When the DF and the WJ Receiver are co-located in the same equipment frame, special software is installed in the IOM108 Module located on the rear of the EFR100 Equipment Frame. This software is stored in a programmed EPROM in the CPU Board, Type 794444 (A5 module) within the IOM108. The EPROM is located in the U7 socket of the CPU board.

An external IEEE-488 controller, if present, is connected to the IOM108 I/O Control Module at the IEEE-488 control connector, A1J1. Refer to Section III for more information on IEEE-488 commands.

2.2.1.2 WJ-98XX DF Antenna

The interconnection between the DF Antenna and the DF is shown in Figure 2-1. A multi-conductor control cable connects the DF Antenna (J6) connector of the DF to the multipin connector on the DF Antenna. The Low Bay RF output of the antenna is connected to the DF ANT -1 (J8) and the High Bay RF output of the DF Antenna is connected to the DF ANT -2 (J9) connector on the rear of the DF. Refer to the Instruction Manual for the antenna for details on connector locations.

2.2.1.2 WJ-98XX DF Antenna - (Continued)

The DF is capable of operating with any of Watkins-Johnson's DF Antennas. The Antennas differ in size, frequency coverage and environmental restrictions. A front panel auxiliary key function (10.1, AUX) will allow the operator to enter in the particular model of DF Antenna that will be used in the DF system. If an OMNI antenna is used (yes: OMNI = ON, no: OMNI = OFF) is entered.

Refer to paragraph 3.1.1.2.10 for a description of this auxiliary function.

2.2.2 INPUT/OUTPUT CONNECTORS

The following paragraphs discuss the DF Subsystem input/output connectors.

2.2.2.1 WJ 9040 DDF102 Direction Finder

The input/output connectors of the DF are shown in Figure 2-2. All connections to the DF are made through on the rear panel. A 25 pin D type connector (J3) mates with a counterpart in the EFR100 Equipment Frame to provide DC power and a communication path to the IOM108 I/O Control Module. Ten SMA female connectors and 5 push-on type RF connectors provide RF signal input and output connections. Three push-on RF connectors and one SMA connector are dedicated for use within the DF. A thirteen-pin female multipin connector (J6) provides control signals to the DF Antenna. These connectors are described in the following paragraphs.

2.2.2.1.1 **DF Input (J1)**

The DF Input is a SMA female connector that accepts the 21.4 MHz Signal Monitor (SM) Output of the WJ Receiver. It is important that this signal be the wideband (or pre-filtered) IF signal from the Receiver. In the case of the WJ-8628-4 Receiver, the SM Output is this signal. The SM signal is amplified and provided as the IF OUT (J2) and is also provided as the SM OUT (J4).

2.2.2.1.2 **IF Output (J2)**

The IF Output is a push-on type RF connector. It is connected to the 21.4 MHz IF Input (J3) connector of the 21.4 IF Demodulator through cable W7. The demodulator will use this signal to generate the phase difference information used in LOB calculations.

2.2.2.1.3 WJ 9040 Backplane Connector (J3)

The WJ 9040 Backplane connector mates with a connector on the EFR100 which will supply DC voltage and a communication path to the IOM108 I/O Control Module.

2.2.2.1.4 SM Output (J4)

The SM Output is available to an external Signal Monitor. This output is provided as the DF uses the only SM signal available from the Receiver.

2.2.2.1.5 DF Video (J5)

The DF Video connector accepts the Video Output (J1) of the 21.4 MHz IF Demodulator. This is the FM demodulated output of the IF Demodulator. It contains the phase information needed for the DF to create a LOB.

2.2.2.1.6 DF Antenna (J6)

The DF Antenna output is a thirteen-pin female multipin connector. It provides the control signals and external voltages necessary for operating the DF Antenna.

2.2.2.1.7 Remote I/O (J7) - (Optional)

The Remote I/O connector is not furnished as part of the standard DF. It is reserved for special applications where direct interface to the DF is required. Standard interfaces RS-232, IEEE-488 and an audio FSK modem are available. Normally all control of the DF comes from the IOM108 I/O Control Module.

2.2.2.1.8 DF Antenna -1 (J8), -2 (J9), -3 (J10)

The DF Antenna inputs are RF SMA female coaxial connectors. The RF outputs of the DF Antenna are connected to the DF-1 (J8) connector (Low Bay), and to the DF-2 (J9) connector (Upper Bay) connector. The DF-3 (J10) connectors is not used at present.

2.2.2.1.9 OMNI (J11)

The OMNI antenna input is a SMA female coaxial input and is available for DF systems which have a general search OMNI antenna.

2.2.2.1.10 RF IN (J12)

The RF Input is an extra RF input to the DF and is not used in the standard configuration.

2.2.2.1.11 RF Output (J13)

The RF Output is a SMA female coaxial connector. It is connected to the RF IN (A1J1) connector of the WJ-8628-4 Receiver. The signal at the RF Output is from one of the following five sources:

- | | |
|------------------------|----------------------------|
| a. DF Antenna -1 (J8) | DF Antenna Low Bay, |
| b. DF Antenna -2 (J9) | DF Antenna High Bay, |
| c. DF Antenna -3 (J10) | not used, |
| d. OMNI Antenna (J11) | OMNI Antenna (if present), |
| e. RF Input (J12) | not used. |

This selection is established by the 10.1 auxiliary function. It establishes which DF Antenna is present and whether an OMNI antenna is installed in the system. The RF Input is usually selected through a special auxiliary function that is not part of the standard DF software.

2.2.2.1.12 IF Control (A5J1)

The IF Control connector is a 40 pin male that is connected to the A4J1 connector of the 21.4 MHz IF Demodulator. A 40 conductor ribbon cable, W9, provides the interconnection. This cable is a permanent part of the DF assembly. This connector provides the DC power and communication path between the main DF chassis and the 21.4 MHz IF Demodulator.

2.2.2.1.13 21.4 MHz IF Demodulator Connector: Video Out (J1)

The Video Output, a SMA female coaxial connector that supplies the FM demodulated signal to the DF for LOB generation. It is connected to the DF Video (J5) connector through coaxial cable, W8, which is a permanent part of the DF assembly.

2.2.2.1.14 21.4 MHz IF Demodulator Connector: 21.4 MHz IF Input (J3)

The 21.4 MHz IF Demodulator is a push-on type RF coaxial connector. The 21.4 MHz IF Input accepts the RF signal from the IF Output (J2) of the DF. The two connectors are linked together by coaxial cable, W7. This cable is a permanent part of the DF assembly.

2.2.2.1.15 21.4 MHz IF Demodulator Connector: Digital Interface (A4J1)

The Digital Interface connector is the interface between the 21.4 MHz Demodulator and the main DF chassis. It is connected to the A5J1 connector on the DF through the 40 conductor ribbon cable, W9.

2.2.2.1.16 21.4 MHz IF Demodulator Unused Connections

The 21.4 MHz IF Demodulator, Type 794446, the same as the 21.4 MHz IF Demodulator used in the WJ-8628-4 Receiver with no modifications. As a result, there are several connectors which appear on this module which are not used in the DF. The connectors are:

- | | |
|-------------------------|------------------------------------|
| a. AUX (J2) | 9 pin SRE female connector, |
| b. BFO Input (J4) | RF push-on type coaxial connector, |
| c. FM Video Output (J5) | RF push type coaxial connector, |
| d. IF Output (A2J4) | SMA coaxial female connector. |

These connectors play no part in the normal operation of the DF although they may be used in troubleshooting the IF Demodulator.

2.2.2.2 WJ-8628-4 Receiver

The Receiver's input/output connectors are shown in Figure 2-3. These connectors are physically mounted on the Receiver rear panel. Two 25-pin D type connectors (J1 and A3J1) mate with a counterpart in the EFR100 Equipment Frame to provide DC power and control signals to the Receiver and status indication outputs. Five SMA female connectors provide signal input and output connections. A nine-pin SRE female connector (J4) provides auxiliary outputs from the demodulator. These connectors are described individually in the following paragraphs.

2.2.2.2.1 Power, Command/Control (J1)

The Power Command/Control 25-pin D type connector mates with the stand-alone power supply (MPS Option) or any one of connectors J1-J8 on the EFR100 Equipment Frame to supply DC voltage and I/O command and control signals to the Receiver. Status conditions, including signal strength, squelch status, AFC Voltage and synthesizer lock, are polled by the IOM108 via this connector.

2.2.2.2.2 50 MHz Reference Input (J2)

The 50 MHz Reference Input SMA connector must be connected to either J1, J2, J3, or J4 on the SRM105A Site Reference Module. It provides a reference for the Receiver's synthesizers.

2.2.2.2.3 Auxiliary Output (J2)

The Auxiliary Output nine-pin SRE female connector provides outputs from the Receiver's demodulator section. These outputs are for connection to user-selected interface devices. The pin assignments are as follows:

- A - Ground
- B - FM Audio Output (5K ohm impedance)
- C - AM/CW/SSB Audio Output (5K ohm impedance)
- D - Signal Strength Output (analog 0 to +10 VDC, 10K ohm)
- E - Carrier Operated Relay (open collector, 30 mA sink to ground, +24 VDC max)
- F - Carrier Operated Squelch (0 or +5 VDC CMOS driver)
- H - Sweep REV (+10V to +15 V = non-inverted spectrum, OPEN = inverted spectrum)
- J - Squelched Audio Output (600 ohm impedance)
- K - AFC Voltage (+/- 2.5V for IF BW) (10K ohm)

2.2.2.2.4 IF Output (A2J4)

The IF Output SMA connector supplies an IF Bandwidth limited 21.4 MHz IF output signal. The level is 20 mVrms minimum into 50 ohms with an input signal level equivalent to AGC threshold.

2.2.2.2.5 Selected Video Output (J1)

The Selected Video Output SMA connector supplies a bandwidth limited video output signal from the AM, FM, CW or SSB detector as selected. The AC coupled signal has a bandwidth from 20 Hz to one-half the IF Bandwidth at a level of 350 mVrms into 75 ohms.

2.2.2.2.6 SM Output (J2)

The SM Output SMA connector provides a broadband 21.4 MHz IF output signal suitable for driving a Signal Monitor. The signal occupies a 6 MHz bandwidth at a level of approximately 5 dB above the Receiver input level.

2.2.2.2.7 RF Input (J1)

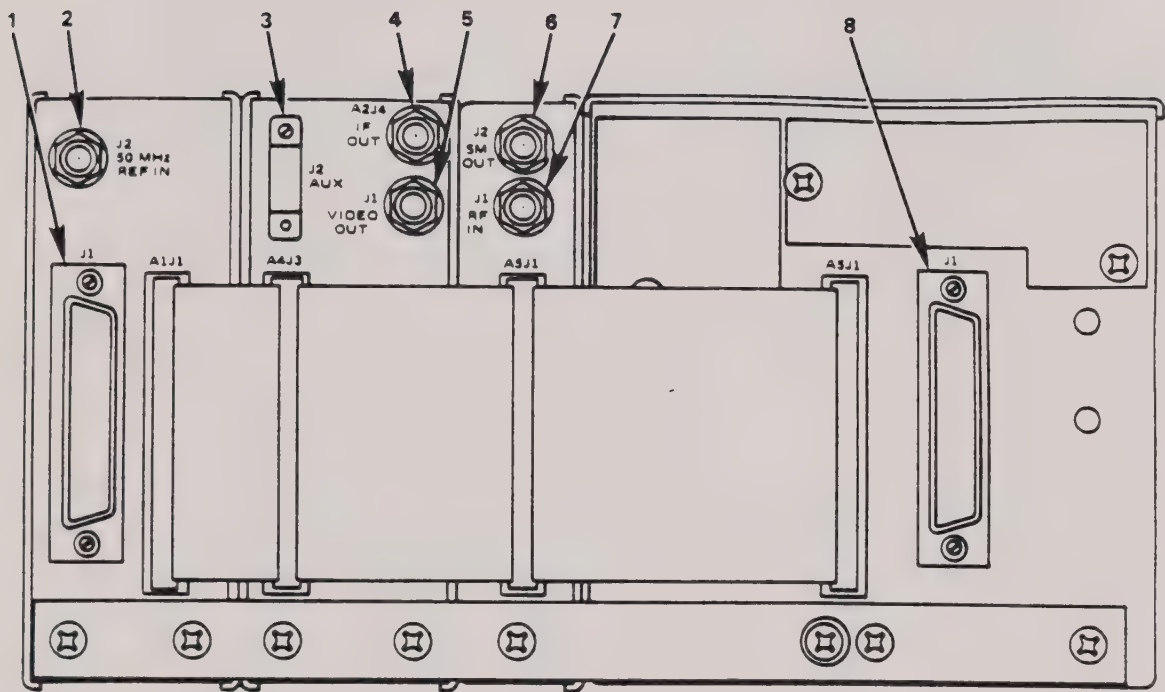
The RF Input SMA connector is the RF signal input for the Receiver. Nominal input impedance is 50 ohms.

2.2.2.2.8 Power Input (A3J1)

In the WJ-8628-4, this connector is used for a parallel power input to the unit.

2.2.2.3 WJ-98XX DF Antenna

The three input/output connectors of the DF Antenna are shown in Figure 2-1. A six conductor control cable or a thirteen conductor control cable carries operating voltages and antenna element switching control signals. Refer to the specific **DF Antenna Instruction Manual** for full interconnection details.



- | | |
|--------------------------------|----------------------|
| 1. Power, Command/Control (J1) | 5. Video Output (J1) |
| 2. 50 MHz Reference Input (J2) | 6. SM Output (J2) |
| 3. Auxiliary Output (J2) | 7. RF Input (J1) |
| 4. IF Output (A2J4) | 8. Power (A3J1) |

Figure 2-3. WJ-8628-4 VHF/UHF Receiver Rear Panel

SECTION III

OPERATION

3.0 INTRODUCTION

The WJ 9040 Direction Finder Subsystem can be operated under local control or remote control. Local control is through front panel keypads. Remote control is through the IOM108 I/O Control Module located on the rear of the EFR100 Equipment Frame. Control of the Direction Finder and the Receiver is accomplished through this common port. The front panel displays show the current status of the units in both local and remote control.

3.1 CONTROLS AND INDICATORS

Individual controls and indicators are discussed in the following paragraphs.

3.1.1 **WJ 9040 DDF102 Direction Finder**

The front panel of the DF is shown in Figure 3-1. Refer to this figure in the following brief discussion that highlights the various operating modes and controls. A full explanation of the operation of the DF is given in the WJ 9040 DDF102 Direction Finder Instruction Manual Operators Reference Guide Appendix.

3.1.1.1 Front Panel Controls

Refer to Figure 3-1 for the location of each of the controls.

3.1.1.1.1 **BACKLIGHT ON Switch**

The BACKLIGHT switch will illuminate the front panel (LCD) status display when turned on.

3.1.1.1.2 **DISPLAY ADJUST Control**

The DISPLAY ADJUST control will allow the user to adjust the viewing angle of the LCD status display for best viewing.

3.1.1.2 Front Panel Keypad Switches

The front panel keypad is comprised of 20 keys which allow for data entry and local control of the DF. Refer to Figure 3-1 for the location of each key.

3.1.1.2.1 IF BW

The IF BW key allows the user to scroll through the 4 available IF Bandwidth Filters (which reside in the 21.4 MHz IF Demodulator). During normal operation, the IF bandwidth will be set to the IF bandwidth currently active in the companion WJ-8628-4 Receiver when the LOB function is activated.

3.1.1.2.2 OFFSET

The OFFSET key adds a heading correction between 0 and 359 to the LOB to make the DF display true north referenced. For example, if the DF Antenna is pointed to 37 degrees, set the offset value to 37 degrees. See paragraph 3.1.4.1, Bearing Offset Display, for a further explanation of this function.

3.1.1.2.3 R/LCL

The R/LCL (remote/local) key allows the operator to put the DF into Remote or Local control. The current operating status is shown in the LCD Status Display (RMT: remote, LCL: local). The key action toggles between the two operating states.

LOCAL: In Local Mode, all control is through the front panel keypad. The LCD status display shows the current operating status.

REMOTE: In Remote Mode, all control is through the WJ 9040 backplane connector of the DF. Control of the DF resides with the IOM108 I/O Control Module. All front panel keys are inactive except R/LCL. The DF can be taken out of the Remote Mode with this key. The DF will then remain in local control until the remote controller places it back into Remote Mode.

3.1.1.2.4 CLR

The CLR key (clear) is used to cancel numeric data entries.

3.1.1.2.5 LOB

The LOB key (Line-Of-Bearing) causes the DF to take a single LOB based on the data taken over one integration time period. This key is valid in GATED - OFF Mode. See GATE key description below for further details.

3.1.1.2.6 INT TIME

The INT TIME key (Integration Time) selects the Integration Time period over which data is taken during a LOB generation cycle. The set of time values are: 0.5, 1, 2, 3, 4, 5, 6, 7, 8 and 9 seconds. The key action scrolls through this set of Integration Times. Preceding the INT TIME key with a valid Integration Time will set the Integration Time to that value.

3.1.1.2.7 GATE

The GATE key offers three LOB generation modes. The GATE key scrolls through its 3 modes. The current GATE Mode is displayed in the LCD status display.

OFF: The GATE Mode is off. LOBs are generated by the LOB key.

ON: The GATE Mode is on. The DF generates LOBs continuously as long as the received signal exceeds the COS threshold setting in the WJ-8628-4 Receiver. The Integration Time is forced to 0.5 seconds for quick action. When the signal becomes inactive, the LOB generation is stopped and the last valid LOB is displayed. When the signal becomes active again, LOB generations resume. Signal durations as short as 150 m sec. can be captured.

CON: The GATE Mode is continuous. The DF generates LOBs continuously regardless of signal activity. The Integration Time period can be set to any valid value in this operating mode.

3.1.1.2.8 Numeric Keys 0 - 9

The NUMERIC keys 0 to 9 allow the operator to enter in data into the DF in local control mode.

3.1.1.2.9 TEST

The TEST key activates built-in test (BIT) routines within the DF. When the key is pressed by itself, it will scroll through the tests available. A brief message will appear in the LCD status display which describes the test. The BIT is activated by entering the test number and then terminating it with the TEST key. Messages will appear in the LCD status display which will aid in the execution of the test. Table 3-1, Test Functions, lists the routines available. Some tests require the operator to verify proper operation (tests 1-5). The rest of the tests (6-11) will be performed with a PASS/FAIL indicator. Refer to the WJ 9040 DDF102 Direction Finder Instruction Manual Operator's Reference Guide Appendix for a complete description of these tests.

Table 3-1. TEST Functions

TEST Number	Function
0	Automated Test which performs TESTS 6 through 11. This test is normally performed during power-up, but can be activated any time after power-up.
1	Keypad Test. Pressing any key will cause that key to be displayed in the Front Panel Status Display to verify proper operation.
2	LCD Status Display Test. All the pixels in the Front Panel Status Display will be turned on and then off to verify proper operation.
3	DF Display LED Test. All of the 60 LEDs in the DF display's compass display will be illuminated (although they will be faint) to verify proper operation.
4	RF Switch Test. The 5 input RF switch can be tested. The operator can select any of the RF inputs on the rear of the DF (J8, J9, J10, J11 or J12) and verify that a signal will pass through to the RF Output port (J13) on the rear of the DF to verify proper operation.
5	DF Antenna Test. This test allows the operator to turn on any of the DF Antennas elements to verify that all antenna elements can be turned on. This is a very useful system test that allows the operator to isolate problems in the system.
6	IF Demodulator Communication Test. This test will verify that the DF can communicate with the IF Demodulator. A PASS/FAIL indicator is displayed.
7	DF Processor Test. This test will exercise the DF Processor (A4A1) module in the DF. It will test the A/D converter and the timing circuits on this module. A PASS/FAIL indicator is displayed.
8	Power Supply Test. The regulated internal voltages, +5, +15 and -15 VDC are measured to see if they have dropped 20% below their regulated values. A PASS/FAIL indicator is displayed.
9	Microprocessor Test. The 8086 microprocessor tests its on-board RAM and clock functions. A PASS/FAIL indicator is displayed.

Table 3-1. Test Functions - (Continued)

TEST Number	Function
10	Antenna Control Line Test. The control lines to the DF Antenna are tested for shorted or heavily loaded conditions. This test could indicate a shorted control cable or a bad DF Antenna. When used with TEST 5, a problem can be isolated to DF, interconnecting cable or DF Antenna. A PASS/FAIL indicator is given.
11	IOM108 Communication Test. The communication path between the DF and the IOM108 I/O Control Module is tested. A PASS/FAIL indication is given.

3.1.1.2.10 AUX

The AUX key allows the user to activate auxiliary functions. When used by itself, it will scroll through the auxiliary functions and display a brief message on the LCD status display describing the auxiliary functions. When preceded with a valid auxiliary function number and then terminated with the AUX key, a particular auxiliary function can be activated. Table 3-2 briefly describes the auxiliary function available. Refer to the WJ 9040 DDF102 Direction Finder Instruction Manual Operators Reference Guide Appendix for a complete description of these functions.

Table 3-2. Auxiliary Functions

AUX Number	Function
1	Time and Date Entry: The Time and Date are entered here. This must be done after power-up since the internal time of day clock is not battery backed up. The current time of day can be viewed using this function once a valid time of day has been entered.
2	Stand-Alone Mode: The Stand-Alone Mode is used when the DF has lost communication with the WJ-8628-4 Receiver or the IOM108 I/O Control Module. Although the DF looks to the Receiver for certain operating parameters during a LOB, it can be operated by itself with certain information such as IF Bandwidth, frequency and COS threshold value provided by the operator through front panel data entries. When in Stand-Alone, TEST appears in the LCD status display to indicate that the DF is in Stand-Alone Mode.

TABLE 3-2. Auxiliary - (Continued)

AUX NUMBER	FUNCTION
3	Stand-Alone Frequency: The frequency of the signal being processed can be entered through this function. This is important since the proper switching of the DF Antenna inputs depends on knowing the frequency of the signal.
4	Stand-Alone COS Threshold: The threshold setting of the COS circuit (0 to 63) can be entered here. This is important in GATED - ON mode. Pressing the COS key on the Receiver will indicate what the COS value of the DF should be set to (assuming that the WJ-8628-4 Receiver is working and that the DF is set to the same IF bandwidth as the Receiver).
10.1	DF Antenna Selection: The type of DF Antenna that is part of the DF system is entered in this function. The presense of an OMNI antenna is also entered. This information resides in non-volatile memory. It should be necessary to enter this one time only.
10.2	Octagon Mode: The Octagon Mode should be turned OFF.

3.1.1.3 DF Display

The DF display is a three digit numeric readout of the LOB surrounded by a ring of 60 discrete LEDs. The LED ring provides a compass-like indicator of the LOB. Refer to Figure 3-2 for the location of the DF display. The LOB displayed is normally the last valid LOB calculated. A LOB value of "888" indicates an invalid LOB value. This value will appear on power-up and it may appear after a built-in-test has been performed.

3.1.1.4 Front Panel Status Display

The front panel status display shows the current operating status of the DF in both local and remote control. The display is a liquid crystal display (LCD) which is configured as 2 lines by 16 alpha-numeric characters. Refer to Figure 3-2 for the location of the display parameters. Table 3-3 shows the power-up status of the DF once the time of day has been entered.

Table 3-3. Power-Up Status Of DF

Bearing Offset	= 0
Quality Factor	= *
Bearing	= 888
Remote/Local	= LCL
IF BW	= IF Bandwidth #1 (narrowest)
Gated Mode	= OFF
INT Time	= 0.5

3.1.1.4.1 BEARING OFFSET Display

The Bearing Offset shows the current offset value. This value is entered by the OFFSET front panel key in Local Mode or by the appropriate command in Remote Mode. The Bearing Offset is a number between 0 and 359 degrees which is added to the LOB calculated by the DF to produce a true north referenced LOB. The DF Antenna has a north reference point (see Figure 1-2) which must be aligned due north. The LOB calculated by the DF is referenced to the north point on the Antenna. If the Antenna is not aligned due north, then the DF display will not be true north referenced. The Bearing Offset allows the operator to offset this error. The Bearing Offset value is the misalignment error of the DF Antenna. For example, if the DF Antenna is pointed 37 degrees away from due north then the offset value is 37 degrees. Note that the offset angle is an unsigned angle (0 to 359) value rather than signed angle (+/- 180) values.

3.1.1.4.2 QUAL FACTOR Display

The Quality Factor is a number between 0 and 9 which indicates the quality of the calculated LOB with 9 being the highest value. This indicator allows the operator to judge if the calculated LOB is to be taken seriously or not. This number is based on the following:

- a. signal strength,
- b. COS threshold broken,
- c. detection mode of signal,
- d. comparison of the four internal LOBs generated
(see Figure 1-2).

3.1.1.4.3 BEARING Display

The LOB is displayed here. It is the same value that is displayed in the DF display. When the Integration Time is greater than 0.5 seconds, this display will flash "****" every second to indicate a LOB is in progress. A LOB value of "888" indicates an invalid bearing. This will appear on power-up and after some built-in tests.

3.1.1.4.4 REMOTE/LOCAL Display

The Remote/Local display indicates the Local (LCL) or Remote (RMT) Mode. The DF is placed into either mode by the front panel key R/LCL or by a command from a remote controller.

3.1.1.4.5 IF BW Display

The IF BW indicator shows which of the 4 IF Bandwidth Filters in the 21.4 MHz IF Demodulator is active. The IF Bandwidth can be set to any of the 4 filters using the IF BW front panel key in Local Mode or the appropriate command in Remote control. However when the DF takes a LOB, it looks to the Receiver for its IF Bandwidth setting and then sets its IF Bandwidth to that value. The DF IF Bandwidth can be set independently in Stand-Alone Mode. Refer to Table 3-2, AUX number 2.

3.1.1.4.6 GATED MODE Display

The GATED Mode indicator shows which of the three GATED modes are currently active. The GATED Mode is set by the GATE front panel key in Local Mode or by the appropriate command in the Remote Mode.

3.1.1.4.7 INT TIME Display

The INT TIME indicator shows which of the ten integration times is active. The integration time is set by the INT TIME front panel key in Local Mode or by the appropriate command in Remote Mode.

3.1.1.4.8 Error Messages, Operator Prompts, Misc. Displays

In addition to showing the current operating status, this display is used to show error messages, operator prompts and other messages to aid in the proper operation of the DF. Refer to the WJ 9040 DDF102 Direction Finder Instruction Manual Operators Reference Guide Appendix for details.

3.1.1.5 REMOTE CONTROL Commands for WJ 9040 DDF102 Direction Finder

Remote commands for the WJ 9040 DDF102 Direction Finder are discussed on the following page.

3.1.1.5.1 Remote Control

The DF can be remote controlled throughout the IOM108 I/O Control Module using IEEE-488 commands. Table 3-3 lists these commands. Refer to the WJ 9040 DDF102 Direction Finder Instruction Manual Operators Reference Guide Appendix for a full description and operating examples.

Table 3-4. WJ 9040 DDF102 Direction Finder Direction Finder IEEE-488 Remote Commands

Command	Operation
APP?	This query command lets the remote system know if the IOM 108 is running an application program with the DF and WJ-8628-4 Receiver.
BWn	Sets the IF Bandwidth to 1 of 4 values.
BW?	Asks for current IF Bandwidth value (1 of 4).
BWC?	Asks for current IF Bandwidth value in kHz.
DFCON	Sets the DF to Gated - Continuous Mode.
DFON	Sets the DF to Gated - On Mode.
DFOFF	Sets the DF to Gated - Off Mode.
DF?	Asks for current Gated Mode setting: Off, On, Con.
EXAMn	Asks for the module type in EFR100 slot n. Will be DF, WJ-8628-4 Receiver or empty.
INTn	Sets the Integration Time to a valid value.
INT?	Asks for the current Integration Time setting.
LCL	Sets the DF into Local Mode.
LOB	Activates the LOB command.
LOB?	Asks for LOB and Quality Factor.
LOBH?	Asks for LOB, Quality Factor, time-of-day, frequency, Detection mode, IF Bandwidth and signal strength.
LOBT?	Asks for LOB, Quality Factor and time-of-day.
OFSn	Sets the Offset value.
OFSn	Asks for current Offset value.

Table 3-4. WJ 9040 DDF102 Direction Finder Direction Finder IEEE-488 Remote Commands - (Continued)

Command	Operation
RMT	Places the DF into Remote control.
RMT?	Asks for LOCAL/REMOTE control status.
SLOTn	Address EFR100 slot n.
SLOT?	Asks for addressed slot.
TESTn	Activates BIT.
TEST?	Asks for BIT result.
TODdd/yy/hh/mm	Sets the time of day clock.
TOD?	Asks for time of day.
VIEW?	Asks for complete operating status of the DF.

3.1.2 WJ-8628-4 RECEIVER

The following paragraphs are an operator's guide designed to familiarize the operator with the different operating modes and sequences available with the Receiver. The function and use of the front panel controls and indicators are explained and detailed Receiver operating instructions are provided. Refer to the **WJ-8628-4 Instruction Manual** for full details.

3.1.2.1 Introduction

The WJ-8628-4 VHF/UHF Receiver incorporates the following operational features:

- a. Local receiver control through momentary contact keypad switches and a tuning knob on the front panel.
- b. Ninety-nine discretely addressed and one implicitly addressed memory channels. The channels are utilized to store front panel data. They may be accessed individually or scanned.
- c. A memory SCAN Mode in which the Receiver scans a selected group of channels.
- d. An F1/F2 frequency sector SCAN Mode in which the Receiver scans an operator programmed frequency sector (Scan Option).

3.1.2.1 Introduction - (Continued)

- e. Remote control capability through the IOM108 Interface or Stand-Alone I/O Interface.
- f. Software flexibility allowing implementation of customer enhancements.

3.1.2.2 Controls and Indicators

The purpose and function of the front panel controls, keypad switches and displays are explained in the following paragraphs.

3.1.2.2.1 **Front Panel Controls**

Refer to **Figure 3-3** for the location of each of the following front panel controls.

3.1.2.2.1.1 **BACKLIGHT ON Switch**

When lifted to the ON position, the BACKLIGHT ON Switch energizes the illuminated backlight in the LCD display. This backlight enhances display readability when a low ambient light level is present. The intensity of the backlight illumination is adjustable inside the unit.

3.1.2.2.1.2 **DISPLAY ADJUST Potentiometer**

The DISPLAY ADJUST Potentiometer adjusts the vertical viewing angle of the LCD display characters. The characters are invisible at maximum CCW and the display is totally illuminated at maximum CW. The operator may adjust this control for optimum display contrast.

3.1.2.2.1.3 **RF GAIN Control**

When in the Manual (MAN) gain Mode, rotating the RF GAIN Control Potentiometer clockwise approximates a logarithmic increase in Receiver gain. The RF GAIN control is inoperative when any AGC Mode is selected.

3.1.2.2.1.4 **AUDIO GAIN Potentiometer**

Rotating the AUDIO GAIN Potentiometer clockwise increases the output of the phone audio signal from the front panel PHONES jack.

3.1.2.2.1.5 PHONES Jack

The PHONES output is intended to drive a 600 ohm or greater headphone set. An output level of 10 milliwatts, minimum, into 600 ohms is available when the AUDIO GAIN control is at maximum clockwise.

3.1.2.2.1.6 TUNE Knob

The TUNE Knob is used to manually set the Receiver's tuned frequency, BFO frequency or COS (Carrier Operated Squelch) threshold. When used for frequency setting, the knob is rotated clockwise to numerically increase the Receiver's tuned frequency or BFO frequency. When used for COS threshold setting, the knob is rotated clockwise to numerically increase the Receiver's squelch threshold (0 minimum, 63 maximum, software controlled).

3.1.2.2.1.7 Cursor Control Switch

The Cursor Control Switch is used to position the LCD display cursor (underscore) to permit the TUNE knob to control tuned frequency, BFO frequency or COS threshold. The switch is toggled either left or right to move the cursor to the desired position. When the cursor is in the proper position, the TUNE knob may be rotated to adjust the desired parameter. The cursor can also be moved to the far right edge of the screen where the TUNE knob is disabled, dictated by a left-pointing arrow adjacent to the frequency display.

3.1.2.2.2 Front Panel Keypad Switches

Refer to Figure 3-4 for the location of each of the following front panel keypad switches.

3.1.2.2.2.1 BFO +/- Switch

In the CW Mode, the BFO +/- Switch is used for direct entry of BFO offset frequencies. Numeric data in kHz is entered followed by the BFO +/- switch as a termination command. If no data is entered, the switch will toggle the offset from "+" (above the tuned signal) to "-" (below the signal).

3.1.2.2.2.2 kHz Switch

The kHz Switch is used for direct entry of the Receiver tuned frequency. Numeric data is entered via the keypad and the kHz Switch is used as a termination command. This key is allowed only when controlling a HF or VHF Receiver when the MHO Option is installed.

3.1.2.2.3 MHz Switch

The MHz Switch is used for direct entry of the Receiver tuned frequency. Numeric data is entered followed by the MHz Switch as a termination command.

3.1.2.2.4 OPR AID Switch

The OPR AID Switch accesses software designed to aid the operator in understanding the sequences and functions available with the Receiver.

3.1.2.2.5 CLR Switch

The CLR (CLEAR) Switch, when pressed after a numeric data entry, clears the display of the numeric data and returns the display to normal status. The entered numeric data is not processed by the Receiver. This switch also clears any error messages and restores the previous display.

3.1.2.2.6 Numeric Switches 0-9

The Numeric Switches are used for direct entry of numeric data required for tuned frequency, BFO offset, COS threshold, memory channel access, dwell time, etc.

3.1.2.2.7 Upper Case/Lower Case Switch

This switch is the upper case/lower case access switch. Some of the keypad switches are dual function, as indicated on the face of the switches. The upward pointing arrow is used to access the upper case functions on these switches, and the downward pointing arrow is used to access the lower case functions. The switch toggles the arrow shown in the lower right corner of the LCD.

3.1.2.2.8 INCL/L-OUT Switch

The INCL/L-OUT Switch is a dual function switch. The upper case INCL function is used as a termination command to INCLUDE a memory channel or string of channels in a scan. The lower case L/OUT function is a termination command to LOCK OUT a memory channel or string of channels from a scan.

3.1.2.2.9 SYS CLR Switch

The SYS CLR Switch accesses the SYSTEM CLEAR routine which allows the operator to empty all memory channel locations and reinitialize the Receiver. The IOM108 units connected via the frame or WJ-9040 Serial I/O can also be cleared by following the prompts.

3.1.2.2.2.10 SET/SCAN Switch

The SET/SCAN Switch is a dual function switch. The upper case SET function is the SCAN SET Mode which allows the operator to review and modify parameters associated with SCANNING. Pressing SET again terminates this mode. The lower case SCAN function is the SCAN Mode which performs a scan of selected memory channels. Pressing the SCAN key again terminates the scan.

3.1.2.2.2.11 DWL Switch

The DWL Switch is the DWELL Mode select which allows the operator to program the various dwell times associated with scan functions, or examine the current dwell time values.

3.1.2.2.2.12 R/LCL COS Switch

The R/LCL COS Switch is a dual function switch. The upper case R/LCL function toggles the Receiver between the REMOTE and LOCAL Modes of operation. The lower case COS (Carrier Operated Squelch) function is used as a termination command for direct entry of COS threshold data, or to examine the numeric value of COS threshold.

3.1.2.2.2.13 EXEC Switch

The EXEC Switch is a termination command for the EXECUTE Mode. The function is used to directly control the status of the Receiver section of the WJ-8628-4 from channel 0 or any of the 99 stored memory channels.

3.1.2.2.2.14 RCL Switch

The RCL Switch is a termination command which changes the CONTROL STATUS to RCLm (RECALL MEMORY). The contents of one of the stored memory channels is displayed without changing the Receiver status.

3.1.2.2.2.15 STO Switch

The STO Switch is a termination command which stores all the currently displayed parameters into the designated memory channel.

3.1.2.2.2.16 DET Switch

The DET Switch is used to select one of the available detection modes and is repeatedly pressed until the desired detection mode is displayed.

3.1.2.2.2.17 IF BW Switch

The IF BW Switch is used to select one of the available IF Bandwidths and is repeatedly pressed until the desired bandwidth is displayed.

3.1.2.2.2.18 GAIN Switch

The GAIN Switch is used to select one of the available gain modes and is repeatedly pressed until the desired gain mode is displayed.

3.1.2.2.3 Front Panel Display

Refer to Figure 3-5 to locate the display areas described in the following paragraphs.

3.1.2.2.3.1 DET MODE Display

This area displays the selected detection mode for the Receiver.

3.1.2.2.3.2 CHAN/ADDR Display

This area displays the channel number of the memory channel being accessed by the Receiver.

3.1.2.2.3.3 IF BW Display

This area displays the selected IF Bandwidth for the Receiver.

3.1.2.2.3.4 CONTROL STATUS Display

This area displays the specific control mode the front panel is executing.

3.1.2.2.3.5 GAIN MODE Display

This area displays the specific gain mode the Receiver is operating under. The three gain modes are: FST, SLO, and MAN.

3.1.2.2.3.6 BFO (kHz) Display

If the Receiver is in the CW Mode, this area displays the BFO offset frequency in kHz currently selected.

3.1.2.2.3.7 SIGNAL STRENGTH/COS THRESHOLD Display

This is a dual purpose display area. It gives a graphic comparison of relative signal strength vs. COS threshold. The upper bar shows signal strength. The length of the upper bar increases from left to right as the signal strength increases. The lower bar shows the COS threshold. The length of the lower bar corresponds to the magnitude of COS threshold entered. A COS of 0 is shown as no bar length (bar completely collapsed at the left). A COS of 63 is shown by maximum bar length. The COS threshold is exceeded when the signal strength bar exceeds the length of the COS bar. The numeric value of the COS threshold appears in place of the bars when the COS key is pressed with no previous data entry.

3.1.2.2.3.8 FREQUENCY (MHz) Display

If no numeric data is entered, this area shows the tuned frequency of the Receiver in MHz. When numeric keys are pressed, the frequency information is erased and the data is entered calculator style in the frequency area. Data entry is identified by the flashing arrow symbol in the upper right corner of the display.

3.1.2.2.3.9 COS STAT Display

This area displays a star (*) when the received signal strength exceeds the COS threshold.

3.1.2.2.3.10 TUNE/AFC Display

This area serves as a visual tuning indicator for the Receiver. When the Receiver is exactly tuned on a signal, the tuning indicator is displayed as a vertical bar. Mistuning of the Receiver is displayed as a right or left deflection of the tuning indicator. On Receivers equipped with AFC, this indicator is replaced by the letter "A" when AFC is selected. The correct tuning is then handled by the digital AFC circuitry.

3.1.2.2.3.11 SHIFT Display

This area displays an upward pointing arrow when the Upper Case key functions with white lettering have been selected, and displays a downward pointing arrow when Lower Case key functions with black lettering have been selected. Single-color labels positioned in the center of the 'key' buttons are active in either upper or lower case.

3.1.2.3 Remote Control Commands for WJ-8628-4 Receiver

The Receiver can be remote controlled throughout the IOM108 I/O Control Module using IEEE-488 commands. Table 3-4 lists these commands. Refer to the WJ-8628-4 Instruction Manual for a full description and operating examples.

Table 3-5. WJ-8628-4 Receiver IEEE-488 Remote Commands

Command	Operation
AFC?	Turns on the Automatic Frequency Control.
AFC/	Turns the Automatic Frequency Control.
AFC?	Asks for current AFC status.
AGC	Turns on Automatic Gain Control.
AGC/	Turns off Automatic Gain Control.
AGC?	Asks for AGC status.
AM	Sets Detection Mode: AM.
AUDn	Polled Audio to slot N is enabled.
AUD?	Asks which slot has the Polled Audio enabled.
BFO [+/-] f	Sets BFO to offset frequency to "f" kHz.
BFO?	Asks for the BFO frequency.
BWn	Selects IF Bandwidth to n, where n = 1 to 4.
BW?	Asks for IF Bandwidth number, n.
BWC?	Asks for IF Bandwidth value in kHz or MHz.
CLR	Clears the tuned status of the Receiver and sets the unit to a default state.
CONT*	Continues a scan from the point is stopped.
CORn or COSn	Sets the Carrier Operated Squelch level to n (where n ranges between 0 and 63).

3.1.2.3 Remote Control Commands for WJ-8628-4 Receiver - (Continued)

Table 3-5. WJ-8628-4 Receiver IEEE-488 Remote Commands - (Cont'd)

Command	Operation
COR? or COS?	Asks for COS setting.
CST?	Asks for COS state (ON or OFF).
CW	Sets Detection Mode: CW.
DET?	Asks for Detection Mode.
DWL*n,m	Set scan Dwell Times where n is On-hit dwell and m is After-hit dwell.
DWL*?	Asks for Dwell Times.
EXAM	Asks for unit description: Receiver type and options.
FM	Sets Detection Mode: FM.
FRQf	Sets tuned frequency to f (in MHz).
FRQ?	Asks for Receiver tuned frequency.
HIT*?	Asks for hit status.
INL*n,[m],[o-p]	Includes the specified Memory Channel for step scanning.
INL*n?	Asks the status of Receiver Memory Channel n.
LCK*n,[m],[o-p]	Locks out the specified Memory Channel for step scanning.
LCL	Sets the Receiver to Local Control.
LSB	Sets Detection Mode: LSB.
MAN*	Stops a scan.
PLS	Sets Detection Mode: PLS.
RCL*n	Recall and execute the Memory Channel n.

3.1.2.3 Remote Control Commands for WJ-8628-4 Receiver - (Continued)

Table 3-5. WJ-8628-4 Receiver IEEE-488 Remote Commands - (Cont'd)

Command	Operation
RFGn	Sets the RF Gain level to n (where n is between 0 and 63).
RFG?	Asks for RF Gain level.
RMT	Sets Receiver to Remote Control.
RMT?	Asks for remote status of the Receiver..
SCN* or STP*	Starts a Channel Scan or Step Scan.
SCN*? or STP*?	Asks scan status of Receiver.
SLOTn	Addresses Slot n (1 of 8) in the EFR100 so that commands are sent to that slot.
SLOT?	Asks for the addressed slot number.
SS?	Asks for the relative Signal Strength of the tuned signal.
STO*n	Stores the current operating status of the Receiver into Memory Channel n.
USB	Sets Detection Mode: USB.
VER?	Asks for software version of the IOM108.
VIEW*[n]	Asks for a compact form of Memory Channel n.

3.1.3 WJ-98XX DF ANTENNA

There are no controls on the DF Antenna. It is controlled by the Direction Finder. Install the unit per the instructions in the WJ-98XX Series DF Antenna Instruction Manual.

3.2 DF SUBSYSTEM OPERATION

DF Subsystem Operation is discussed in the following paragraphs.

3.2.1 GENERAL DF OPERATING PRINCIPLES

Successful DF operation depends on the correct operation of the DF and the Receiver. There are different settings of the DF and Receiver which will optimize the operation against different signal types. Some operating modes will be described below for direction finding against certain signal types. Refer to the WJ 9040 DDF102 Direction Finder Instruction Manual Operators Reference Guide Appendix for most of the details of the System Direction Finding functions. Refer to the Instruction Manuals for other units in the DF subsystem as required.

3.2.1.1 DF Site Selection

The selection of the site for the DF Subsystem is very important. The ideal site is a clear, flat field with no obstructions which can reflect or re-radiate signals causing multipath problems (same signal from two different locations). These conditions are typical of a "clean" site. The DF System accuracy specification of 3 degrees RMS is valid for "clean" site conditions.

Mobile systems usually do not have the advantage of careful site selection. However when choosing a site for mobile applications try to keep away from metal fences, buildings, power lines, poles, etc. which are potential reflection sources. Try to elevate the DF Antenna so that it has a clear line of site and is not obstructed at the same elevation height by some object. An obstruction of this type will cause a serious degradation of the DF system accuracy. It is not possible to hide the DF Antenna and retain good DF performance.

3.2.1.2 Signal Acquisition

The Receiver operator is responsible for acquiring the signal of interest. The operator must set the proper frequency, demodulation type, COS threshold setting and most important the IF Bandwidth. The signal must be tuned so that no part of the signal lies outside of the IF Bandwidth. This is very important to the successful operation of the DF. When the DF takes a LOB it will set its IF Bandwidth to that of the Receiver. If a large portion of the signal lies outside of the IF Bandwidth, the LOB accuracy will suffer.

IF Bandwidth Selection Rule

The IF Bandwidth should be selected so that the signal lies just within the IF Bandwidth limits. The IF Bandwidth should not be set so that the signal extends beyond either end of the IF filter. However, the IF bandwidth should not be set too wide which can allow unwanted noise in the system.

3.2.1.2 Signal Acquisition - (Continued)

The DF has no built-in signal recognition capability and relies on the operator to accurately set the signal parameters. Monitoring the Receiver's audio and observing the signal on a Signal Monitor will assist in this effort.

3.2.1.3 Signal Types

Detailed procedures for some common signal types are discussed in the following paragraphs.

3.2.1.3.1 Continuous Signal

The DF can be operated in various modes against a continuous signal. The operator can choose one of the three GATED Modes:

- | | |
|--------------|---|
| a. GATED OFF | The LOB front panel key will take a LOB based on the data collected over the period of one Integration Time Period. |
| b. GATED ON | The DF takes LOBs continuously as long as the signal breaks the COS threshold setting in the Receiver. The signal level will appear in the Receiver front panel display and the COS threshold should be set below that level. The Integration Time is set to 0.5 seconds. |
| c. GATED CON | The DF takes LOBs regardless of COS threshold setting. If the signal is present but is below COS threshold, the LOBs will still be valid but the Quality Factor will be lower. The Integration Time can be set to any value. |

If the signal is continuous, there is probably no need to use the GATED - ON Mode.

3.2.1.3.1.1 Integration Time Selection

The Integration Time selection can affect the LOB accuracy. Longer Integration Time values will increase the LOB accuracy. This is particularly important when the signal level approaches threshold. The DF system accuracy can be increased through use of longer Integration Times. A penalty of longer Integration Times is that the DF takes longer to calculate a LOB which may create a problem if the signal is not present during the entire Integration Time period. In that case the LOB may have a large error. A further aid to increasing sensitivity is to make sure that the IF Bandwidth is not set too wide allowing unwanted noise into the DF.

3.2.1.3.2 Short Duration Signals

A short duration signal of less than a second can be processed by this system. Signals as short as 150 m sec. can be captured providing that the DF System is setup properly. As the signal duration decreases below 0.5 second, the DF System accuracy can not be maintained. The DF accuracy will degrade with decreased signal duration.

The operator should set the Receiver to the signal parameters such as frequency, IF Bandwidth, demodulation mode and COS threshold. The DF should be placed into GATED-ON Mode. When the signal becomes active, the DF will take LOBs over an Integration Time of 0.5 seconds. If the signal is active for more than 150 m seconds within the 0.5 second Integration Period, a LOB will be displayed. It is very important that the COS threshold setting in the Receiver be correct since the DF relies on this signal to indicate when the signal is active. When the COS signal is inactive, no LOBs are generated. Data is collected for the LOB calculation only when the COS signal is active.

The Integration Time select can not be used for signals which approach threshold. The Integration Time is forced to 0.5 seconds. The IF Bandwidth selection should be checked for minimum allowable setting.

3.2.1.4 Receiver Scanning Application Program

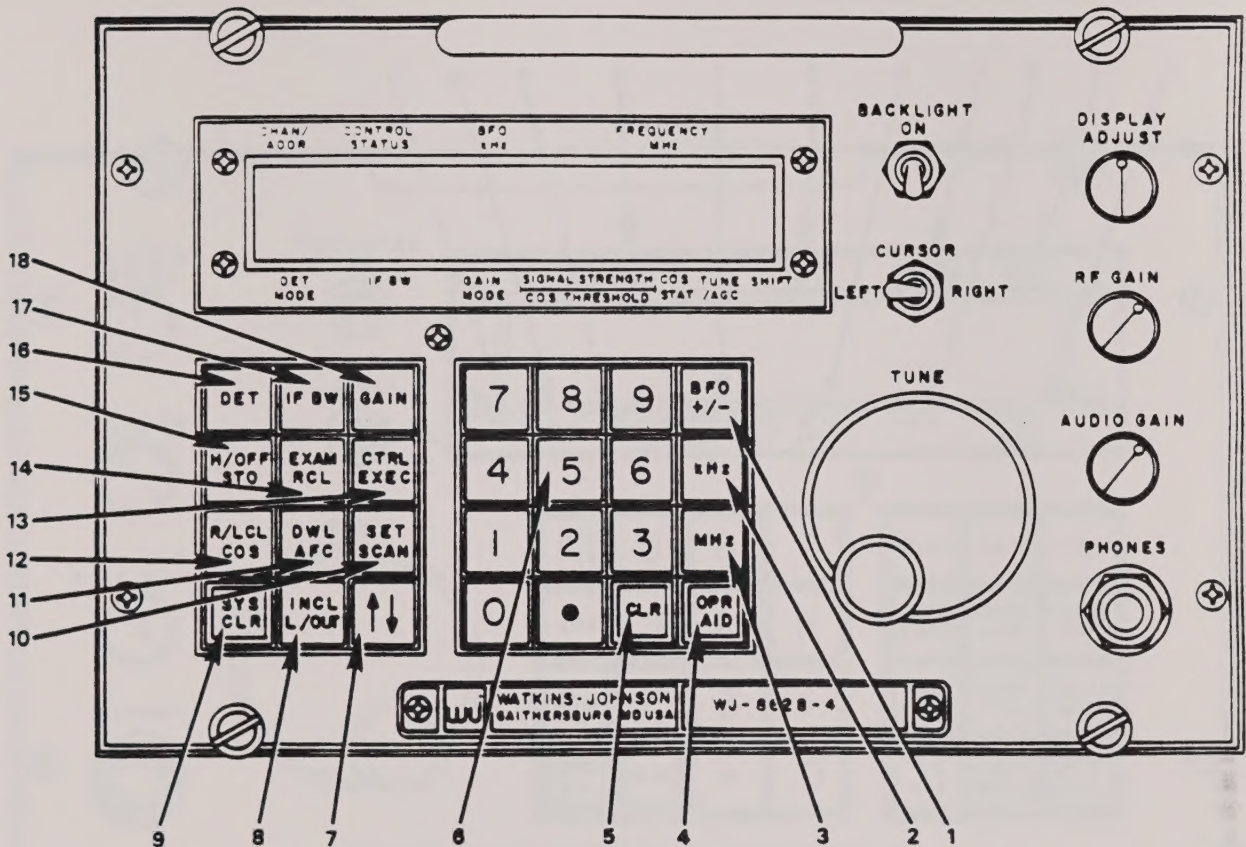
The WJ-8628-4 Receiver is capable of scanning through a set of channels. There is an application program in the IOM108 I/O Control Module which will allow the IOM to task the DF to take a LOB whenever the Receiver gets a hit while scanning. This method of operation is preferred since the DF or the operator can not predict when the Receiver will get a hit. Place the WJ-8628-4 Receiver into SCAN Mode (refer to the WJ-8628-4 Receiver Manual). Start the scanning. Place the DF into Remote Mode using the R/LCL front panel key. The DF will be set to GATED - OFF and the LOB function of the DF will be activated by the IOM108 I/O Control Module. The Integration Time of the DF is set to 1 second less than the ON HIT time of the Receiver scanning parameter. If the ON HIT time is 1 second, then the Integration Time is set to 0.5 seconds. For good DF operation, it is recommended that the ON HIT time be equal to the POST HIT time of the Receiver's scanning parameters.

3.2.2 DF SUBSYSTEM BUILT-IN TEST (BIT)

The DF Subsystem has the following BIT capabilities.

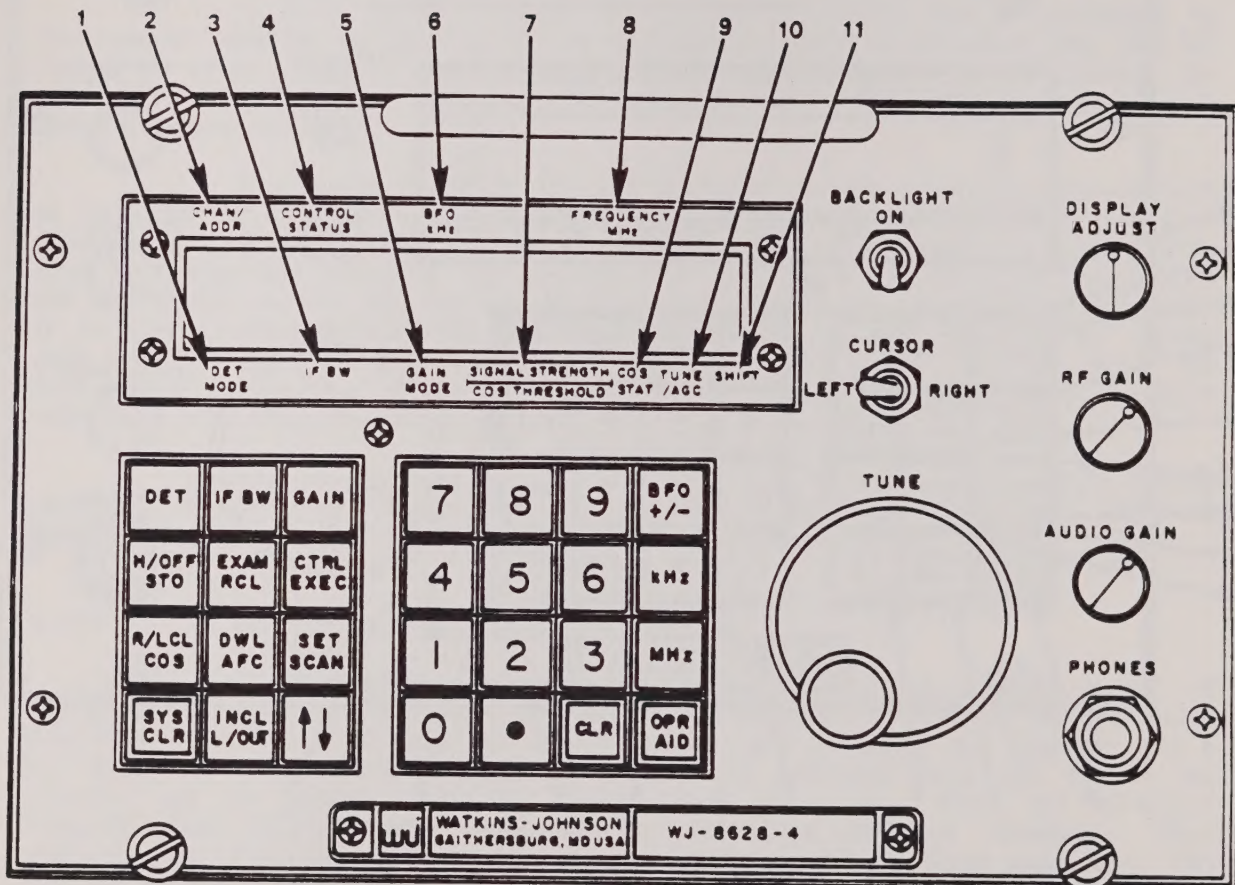
3.2.2.1 WJ 9040 DDF102 Direction Finder Direction Finder

The Direction Finder provides the control over most of the system BIT functions. Refer to the WJ 9040 DDF102 Direction Finder Instruction Manual Operators Reference Guide Appendix for full details of these tests.



- | | |
|--|---|
| 1. BFO +/- (BFO Offset Entry Switch) | 10. SET SCAN (SCAN/SCAN SET select) |
| 2. kHz Tuned Frequency Entry | 11. DWL (Dwell select),(SCAN function) |
| 3. MHz Tuned Frequency Entry | 12. L/LCL COS (COS Threshold Set/
Remote and Local Select) |
| 4. OPR AID (Operator Aid Switch) | 13. EXEC (Execute Select) |
| 5. CLR (Numeric Entry CLEAR Switch) | 14. RCL (Recall Select) |
| 6. Numeric Entry Switches 0-9 | 15. STO (Store Select) |
| 7. (Lower Case/Upper Case Selection) | 16. DET (Detection Mode Select) |
| 8. INCL L/OUT (Include/Lock Out
Memory Channels), (SCAN Function) | 17. IF BW (IF Bandwidth Select) |
| 9. SYS CLEAR (System Clear) | 18. GAIN (Gain Mode Select) |

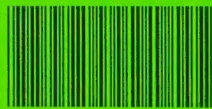
Figure 3-4. Front Panel Keypad Switches



- | | |
|--------------------------------|--|
| 1. DET MODE (Detection Mode) | 7. SIGNAL STRENGTH/COS THRESHOLD |
| 2. CHAN/ADDR (Channel Address) | 8. FREQUENCY (MHz), (Receiver Tuned Frequency) |
| 3. IF BW (IF Bandwidth) | 9. COS STAT (Carrier Operated Squelch Status) |
| 4. CONTROL STATUS | 10. TUNE/AFC/ (AFC Tuning Indicator) |
| 5. GAIN MODE | 11. SHIFT (Upper/Lower Case Functions) |
| 6. BFO Offset | |

Figure 3-5. LCD Parameter Display Locations

MP MASTER



MA31064